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Original scientific paper

STATISTICAL ANALYSIS ON INFORMATION TECHNOLOGY IMPACT IN QALITY LEARNING OF MATHEMATICS (FOR GRADES VI-IX)

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Abstract

This paper provides a brief overview of the results analyzed by the role and effect of information technology, which can be used to enhance learning and motivate students to be more engaged in the subject of mathematics. The main purpose of the study is to compare the results of the students who are using information technology in learning with those students who are not using it. While, the other goal was to understand students' perceptions regarding the application of information technology in the subject of mathematics. The study presents comparative research model, where through the results of students are analyzed qualitative data from surveys, as well as quantitative data from the results of tests performed by students in the subject of mathematics. In this study the results were analyzed through the presentation of percentages in diagrams, descriptive statistics, indicators of central tendency, variability indicators, shape indicators, empirical rule and Chebyshev theorem. Therefore, statistical analysis of the results of this research shows that the use of information technology impacts the increase of learning and motivation of students in the subject of mathematics.

Keywords: Information technology, mathematics, learning and statistics.

1. Introduction

The development of information technology has influenced the change of teaching methods through its application in learning of mathematics. The application of information technology in the learning process aims to improve and enhance learning, as well as the quality of teaching. Furthermore, the integration of technology in the subject of mathematics can increase the abilities and skills of students based on global needs, through the development of competencies and their motivation in the classroom [1]. Through the use of information technology, the curriculum framework provides modifiable solutions to address students' differences in the learning process and their special needs, thus contributing to the full development of the learning potential of each individual [2]. Taking the consideration, the individual needs and learning styles, learning experiences in school will foster motivation to learn as a condition for improving the level of student achievement [3]. The need to perform fast and immediate mathematical calculations, dictated by military technology (ballistics and decoding), space exploration, etc., have been a strong impetus for the development of the electronics industry in general and that of computers in particular. Building computers at high speeds helps mathematicians to calculate and make the situation clearer than ever before and the meaning of calculation would not make sense without mathematics [4]. Perhaps information technology is not being widely applied in teaching and learning [5]. However, ICT (Information and Communication Technology) is part of the student environment, some of which are mobile devices, computers and the internet which are very popular and used, however there are some new services that can be done through the internet which are unknown to users [6].

2. Literature review

The use of information technology in the subject of mathematics has long been a topic reviewed by mathematics professors. Studies are showing that information technology is changing the teaching and learning processes in mathematics, adding elements of vitality to both inside and outside the classroom. Information technology becomes more important when used as a tool for problem solving, conceptual development and critical thinking in mathematics. Using information technology as a tool, students spend productive time developing strategies for solving complex problems and developing a deeper understanding of different concepts from mathematics [7]. Information technology promotes greater collaboration between students and encourages communication and knowledge sharing. It provides quick and accurate information to students, and this contributes to positive motivation. IT also allows students to focus on strategies and interpretations of responses, rather than spending time on tedious calculations. Information technology also supports constructivist pedagogy, where students use technology to explore and achieve a conceptual understanding of mathematical concepts [8].

3. Research methodology

The field of study for this research is the statistical analysis of the use of information technology in learning of mathematics. The main purpose of the research is to compare the results from the impact of information technology, as well as to understand students' perceptions regarding the application of information technology in the subject of mathematics. The research methodology is a comparative research model, where qualitative data were collected from student surveys, while quantitative data were collected from test results performed by students in mathematics. The analysis of the results was conducted through the presentation of percentages in diagrams, descriptive statistics, indicators of central tendency, variability indicators, shape indicators, empirical rule and Chebyshev theorem. This research was conducted in the primary and lower secondary school "Heronjtë e Lumës" - Vërmica in the municipality of Prizren. The research sample was 40 students, from 6-th, 7-th, 8-th, and 9-th grades. Statistics applied in this paper include data collection, data management, analysis, interpretation and inference using statistical analysis [9].

4. Data analysis

Qualitative data: In the analysis of qualitative data, a survey was conducted with students through a questionnaire and the results obtained through diagrams are presented, as follows:

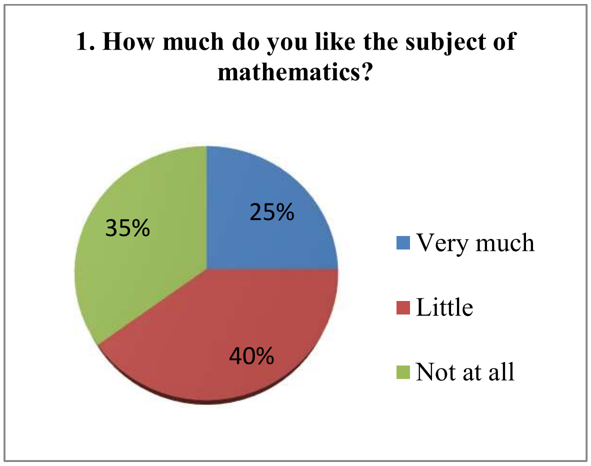


Diagram 4.1. Question 1

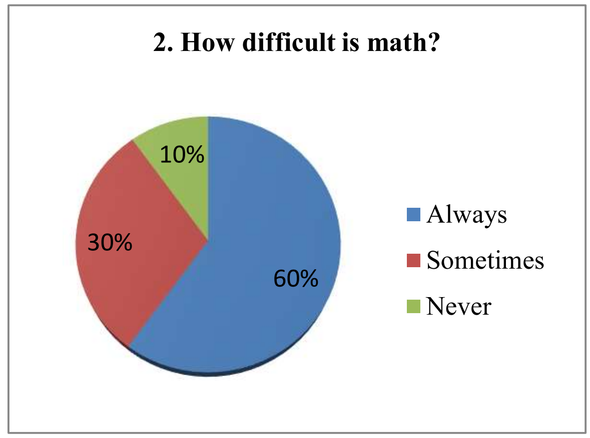


Diagram 4.2. Question 2

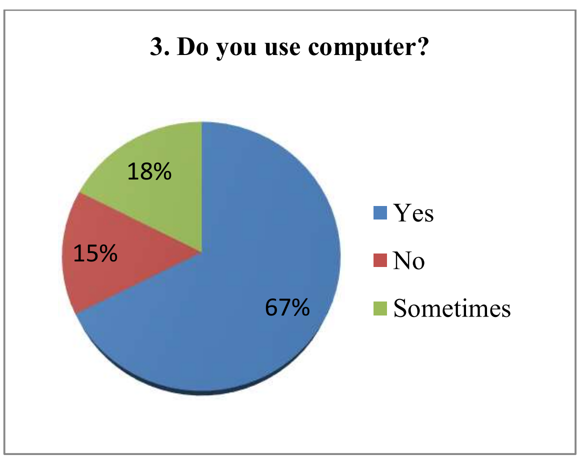


Diagram 4.3. Question 3

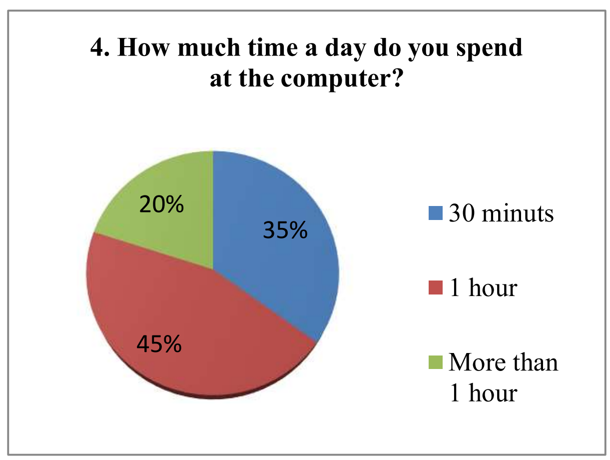


Diagram 4.4. Question 4

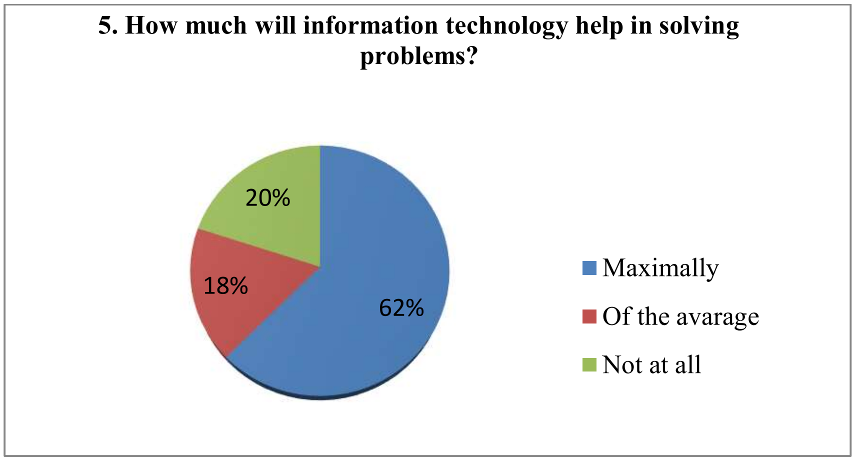


Diagram 4.5. Question 5

Quantitative data: The analysis of quantitative data during the research was based on the primary school and also on the lower secondary school "Heroes of the River" - Vërmica in the municipality of Prizren, where students participated in the research in grades VI, VII, VIII and IX.

Phase 1 – In the first phase of the research a large amount of quantitative data was collected in order to obtain generalizations. Information was collected from the results of tests performed in the subject of mathematics, while qualitative data were collected from questionnaires.

Phase 2 – In the second phase, an action plan has been drafted. At this stage we have tried to do research with sixth, seventh, eighth and ninth grade students with 10 students. So the sample taken is 40 students.

Phase 3 – In the third phase we tried to divide the students of each class into two groups, where one group will use information technology, while the other group will not use information technology.

Phase 4 – In the fourth phase first research tests will be done with the students, who have used the information technology and with those who have not used the information technology.

Phase 5 – In the last stage, comparisons will be made about the effect of the use of information technology in the subject of mathematics by those who have used it compared to those who have not used it [10].

5. Descriptive statistics

Statistics is the science of collecting, organizing, presenting, analyzing and interpreting data of variable mass phenomena. Data is a collection of facts and opinions that we will work with, usually in numerical form. Statistical data (attribute or feature (variables) represent each feature unique to each and common to all statistical units [11]. From the example of the paper statistical data consist of the number of students selected in primary and lower secondary school "Heronjtë e Lumës" in Vërmica, municipality of Prizren. Samples are selected from the entire population of the school from students of grades VI, VII, VIII and IX (Table 5.1).

Table 5.1. Research sample

Data from the class:	X_i
VI	10
VII	10
VIII	10
IX	10
Σ	40

Data can be presented: *By listing them and leaving space between them, using the community, as well as in the form of a frequency table*.

Example: We are presenting the sample of points obtained from the tests of students from the subject of mathematics, where the first sample presents the data of students who have not used information technology, while the second sample presents the data of students who have used information technology.

Sample 1: Test scores that students have not used information technology:

Data listing: 55 36 74 62 89 95 89 66 72 49 95 77 89 74 70 83 41 74 74 79

Set: {55, 36, 74, 62, 89, 95, 89, 66, 72, 49, 95, 77, 89, 74, 70, 83, 41, 74, 74, 79}

Frequency table (Table 5.2):

Table 5.2. Frequency of test scores that did not use IT

x	36	41	49	55	62	66	70	72	74	77	79	83	89	95
f	1	1	1	1	1	1	1	1	4	1	1	1	3	2

Sample 2: Test scores that students have used information technology:

Data listing: 25 59 82 77 92 95 87 71 66 55 100 82 89 82 77 66 44 82 74 89

Set: {25, 59, 82, 77, 92, 95, 87, 71, 66, 55, 100, 82, 89, 82, 77, 66, 44, 82,74, 89}

Frequency table (Table 5.3):

Table 5.3. Frequency of test scores who used IT

x	25	44	55	59	66	71	74	77	82	87	89	92	95	100
f	1	1	1	1	2	1	1	2	4	1	2	1	1	1

The most common presentation for data comparison is the "Steam-Leaf" diagram (Figure 5.1).

Sample 1: Test scores that students have not used information technology (Figure 5.1):

55 36 74 62 89 95 89 66 72 49 95 77 89 74 70 83 41 74 74 79

Sample 2: Test scores that students have used information technology (Figure 5.2):

25 59 82 77 92 95 87 71 66 55 100 82 89 82 77 66 44 82 74 89

Based on the "Steam-Leaf" diagram, we notice that with the use of information technology the percentage using it has increased. We can say that without using information technology the average is around 70s and 80s, while using information technology the average is around 80s and 90s. However, in terms of points under 40 we can not say that there are many differences. Also in the interval (40,70) we can not notice a change that should be noted. In the range (90,99) there is no difference with the use of information technology. But, with the use of information technology, a maximum of 100 points has been achieved, which distinguishes it from sample 1.

not used information technology		used information technology
	2	5
6	3	
1 9	4	4
5	5	9 5
6 2	6	6 6
9 4 4 0 4 7 2 4	7	7 1 7 7 4
3 9 9 9	8	2 7 2 2 2 9
5 5	9	2 5
	10	0

Figura 5.1. : Sample 1 , Sample 2

6. Statistical indicators

Indicators of central tendency: Average, Median, Mode.

From the example of the paper, we have:

Sample 1: Test scores that students have not used information technology:

$$\bar{x} = \frac{\sum x}{n} = \frac{1443}{20} = 72.15, \qquad \hat{x} = \frac{74+74}{2} = \frac{148}{2} = 74, \qquad Mo = 74.$$

We can see that $\bar{x} < \hat{x}$, therefore the distribution is tilted to the right.

Sample 2: Test scores that students have used information technology:

$$\bar{x} = \frac{\sum x}{n} = \frac{1494}{20} = 74.7, \qquad \hat{x} = \frac{77+82}{2} = \frac{159}{2} = 79.5, \qquad Mo = 82.$$

Even in this case we can see se $\bar{x} < \hat{x}$, therefore the distribution is tilted to the right.

Variability indicators: Range, Variance, Standard Deviation.

Range: $R = x_{max} - x_{min}$, **Variance:** $s^2 = \frac{\sum(x-\bar{x})^2}{n-1}$, **Standard Deviation:** $s = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}}$.

From the example of the paper, we have:

Sample 1: Test scores that students have not used information technology:

$$R = x_{max} - x_{min} = 95 - 36 = 59, \; s^2 = \frac{\sum(x-\bar{x})^2}{n-1} = \frac{5350.5}{19} \approx 281.61, \; s = \sqrt{281.61} \approx 16.78.$$

Sample 2: Test scores that students have used information technology:

$$R = x_{max} - x_{min} = 100 - 25 = 75, \; s^2 = \frac{\sum(x-\bar{x})^2}{n-1} = \frac{11681.8}{19} \approx 614.83, \; s = \sqrt{614.83} \approx 24.8.$$

Shape indicators: Relative data positions are: Percentiles, Quartiles, Five-numbers (box pot), Intercartilate, z-result.

Percentile: For a data x from a data set, x is called the P percentile of data if the percentage of data that is less than or equal to x is P. The number P is the rank of the data percentile x.

Quartiles: For any data set the second Q_2 data quadrant is the median itself. The two subsets are divided into: The lower set of data that is strictly smaller than Q_2 and the upper set of data that is strictly larger than Q_2. The first quarter Q_1 is the median of the lower community and the third quarter Q_3 is the median of the upper set.

Five-numbers: Five-numbers are called summarize of five-numbers $\{x_{min}, Q_1, Q_2, Q_3, x_{max}\}$. These five numbers are useful for constructing the box plot.

Interquartiles: Interquartiles are called the size we denote by:

$$IRQ = Q_3 - Q_1.$$

z-result: z-result of a data is called the z number defined by the formula:

$$z = \frac{x-\bar{x}}{s}.$$

The z-result shows how many standard deviations the data x is away from the data center, their median. If z is negative then x is less than the median, if z is positive then x is greater than the median of the data.

From the example of the paper, we have:

Sample 1: Test scores that students have not used information technology:

Value 36 is $\frac{1}{20} = 0.05$ or 5 %, therefore 36 is the 5th percentile.

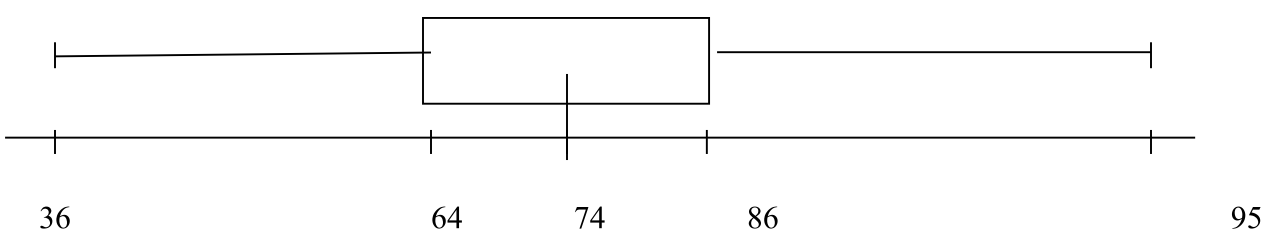
Value 55 is $\frac{4}{20} = 0.2$ or 20 %, therefore 55 is the 20th percentile.

Value 83 is $\frac{15}{20} = 0.75$ or 75 %, therefore 83 is the 75th percentile.

$$Q_2 = \frac{74+74}{2} = \frac{148}{2} = 74,$$

$$U = \{36, 41, 49, 55, 62, 66, 70, 72, 74, 74\},\ \ L = \{74, 74, 77, 79, 83, 89, 89, 89, 95, 95\},$$

$$Q_1 = \frac{62+66}{2} = \frac{128}{2} = 64 \qquad Q_3 = \frac{83+89}{2} = \frac{172}{2} = 86.$$



Figuure 6.1 Box plot for sample 1

$$\text{IRQ} = Q_3 - Q_1 = 86 - 64 = 22$$

$$z_1 = \frac{x-\bar{x}}{s} = \frac{55-72.15}{16.78} = \frac{-17.15}{16.78} = -1.02, \qquad z_2 = \frac{x-\bar{x}}{s} = \frac{36-72.15}{16.78} = \frac{-36.15}{16.78} = -2.15,$$

$$\vdots$$

$$z_{19} = \frac{x-\bar{x}}{s} = \frac{74-72.15}{16.78} = \frac{1.85}{16.78} = 0.11, \qquad z_{20} = \frac{x-\bar{x}}{s} = \frac{79-72.15}{16.78} = \frac{6.85}{16.78} = 0.41.$$

By repeating this process we gain:

$$-1.02 \quad -2.15 \quad 0.11 \quad \dots \quad \dots \dots \quad 0.11 \quad 0.11 \quad 0.41$$

Sample 2: Test scores that students have used information technology:

Value 25 is $\frac{1}{20} = 0.05$ or 5 %, therefore 25 is the 5th percentile.

Value 44 is $\frac{2}{20} = 0.1$ or 10 %, therefore 44 is the 10th percentile.

Value 92 is $\frac{18}{20} = 0.9$ or 90 %, therefore 92 is the 90th percentile.

$$Q_2 = \frac{77+82}{2} = \frac{159}{2} = 79.5$$

$$U = \{25, 44, 55, 59, 66, 66, 71, 74, 77, 77\}, \; L = \{82, 82, 82, 82, 87, 89, 89, 92, 95, 100\},$$

$$Q_1 = \frac{66+66}{2} = \frac{132}{2} = 66, \qquad Q_3 = \frac{87+89}{2} = \frac{176}{2} = 88,$$

$$x_{min} = 25 \quad Q_1 = 66 \quad Q_2 = 79.5, \quad Q_3 = 88, \quad x_{max} = 100.$$

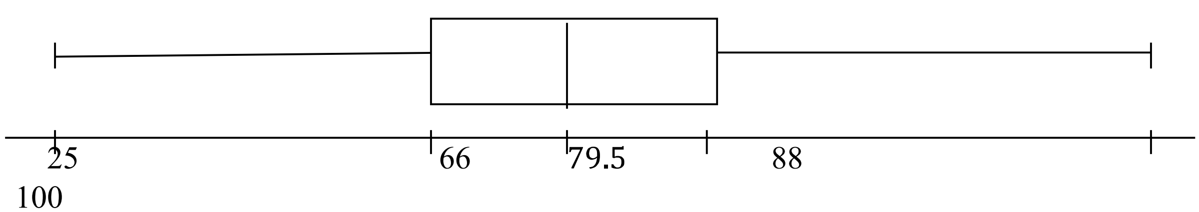


Figure 6.2 Box plot for sample 2

$$\text{IRQ} = Q_3 - Q_1 = 88 - 66 = 22.$$

$$z_1 = \frac{x-\bar{x}}{s} = \frac{25-74.7}{24.8} = \frac{-49.7}{24.8} = -2.01, \qquad z_2 = \frac{x-\bar{x}}{s} = \frac{59-74.7}{24.8} = \frac{-15.7}{24.8} = -0.63,$$

$$\vdots$$

$$z_{19} = \frac{x-\bar{x}}{s} = \frac{74-74.7}{24.8} = \frac{-0.7}{24.8} = -0.03, \qquad z_{20} = \frac{x-\bar{x}}{s} = \frac{89-74.7}{24.8} = \frac{14.3}{24.8} = 0.58.$$

By repeating this process we gain:

$$-2.01 \quad -0.63 \quad 0.29 \quad \ldots \quad \ldots \ldots \quad 0.29 \quad -0.03 \quad 0.58$$

7. Empirical Rule and Chebyshev's Theorem

Empirical Rule: If a data set is approximately in the form of a "good" relative frequency histogram (A relative frequency histogram is the same as a regular histogram, but instead of naming the frequencies on the vertical axis, we use the percentage of total data that is present in that rectangle. "Good" histograms are those that show that the data have a symmetrical distribution), then these conditions apply:

- Approximately 68 % of the data lie in the edge spacing $\bar{x} \pm s$ for sample
- Approximately 95 % of the data lie in the edge spacing $\bar{x} \pm 2s$ for sample
- Approximately 99.7 % of the data lie in the edge spacing $\bar{x} \pm 3s$ for sample

From the example of the paper we notice that the histogram of relative frequencies from sample 2 has a "good" distribution, therefore we apply the empirical rule.

$$\bar{X} = 74.7, \qquad s = 24.8.$$

$$(49.9, 99.5) = (\bar{x} - s, \bar{x} + s) = (74.7 - 24.8, 74.7 + 24.8)$$

In the interval $(49.9, 99.5)$ according to the empirical rule will lie around 68 % of data.

$$(25.1, 124.3) = (\bar{x} - 2s, \bar{x} + 2s) = (74.7 - 2 \cdot 24.8, 74.7 + 2 \cdot 24.8).$$

In the interval $(25.1, 124.3)$ according to the empirical rule will lie around 95 % of data.

$$(0.3, 149.1) = (\bar{x} - 3s, \bar{x} + 3s) = (74.7 - 3 \cdot 24.8, 74.7 + 3 \cdot 24.8).$$

In the interval $(25.1, 124.3)$ according to the empirical rule will lie around 99.7 % of data.

Chebyshev's Theorem: Chebyshev`s Theorem applies to data sets when:

- At least $\frac{3}{4}$ of data lie within two standard deviations from the mean of the data, within the interval with extreme points $\bar{x} \pm 2s$ for sample.
- At least $\frac{8}{9}$ of data lie within three standard deviations from the mean of the data, within the interval with extreme points $\bar{x} \pm 3s$ for sample.
- At least $1 - \frac{1}{k^2}$ of data lie within k standard deviations from the mean of the data, within the interval with extreme points $\bar{x} \pm ks$ for sample, where k is an integer greater than 1.

From the example of the paper we see that the histogram of relative frequencies from sample 1 has a "bad" distribution, so we apply Chebyshev's theorem.

$$\bar{X} = 72.15, \quad s = 16.78.$$

$$(38.59, 106.06) = (\bar{x} - 2s, \bar{x} + 2s) = (72.15 - 2 \cdot 16.78, 72.15 + 2 \cdot 16.78).$$

In the interval $(38.59, 106.06)$ according to Chebishev`s will lie around 75 % of data.

$$(21.81, 122.49) = (\bar{x} - 3s, \bar{x} + 3s) = (72.15 - 3 \cdot 16.78, 72.15 + 3 \cdot 16.78).$$

In the interval $(21.81, 122.49)$ according to Chebishev`s will lie around 88.89 % of data.

8. Conclusion

Integrating information technology into mathematics learning can make the learning process more effective, as well as enhance students' skills in understanding basic concepts. Therefore, the statistical analysis of the research results conducted in the primary and lower secondary school "Heronjtë e Lumës" in Vermica in the municipality of Prizren, are showing that students who have used information technology in the learning process have reached a higher average in tests. Also, statistical analysis from student surveys is showing positive perceptions regarding the integration of information technology in the learning of concepts from the subject of mathematics. Therefore, this statistical analysis highlights the role and impact of information technology in the highest quality learning of mathematics subject in students of grades VI-IX. The results of this research proved that mathematics can be as easy to learn as other subjects, if the right and proper way is found to explain it. This research also made it possible to change the beliefs of students who found the subject of mathematics very difficult to learn. The motivation of the students was more pronounced and they were looking forward to the use of technology in the mathematics lessons.

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